

Claims

- [c1] What is claimed is:
1. An extrusion-free wet cleaning process for post-etch Cu-dual damascene structures, the process comprising:
providing a wafer comprising a silicon substrate and at least one post-etch Cu-dual damascene structure, the post-etch Cu-dual damascene structure having a via structure exposing a portion of a Cu wiring line electrically connected with an N^+ diffusion region of the silicon substrate and a trench structure formed on the via structure;
applying a diluted H_2O_2 solution to the wafer to slightly oxidize the surface of the exposed Cu wiring line;
washing away cupric oxide generated in the oxidation step by means of a cupric oxide cleaning solution containing diluted HF, NH_4F or NH_2OH ; and
preventing Cu reduction reactions on the N^+ diffusion region connected Cu wiring line.
 - [c2] 2. The process of claim 1 wherein the Cu wiring line electrically connected with an N^+ diffusion region of the silicon substrate serves as a cathode in the cupric oxide cleaning solution.
 - [c3] 3. The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises purging inert gas onto the wafer during the application to the wafer of the diluted H_2O_2 solution.
 - [c4] 4. The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises adding a Cu corrosion inhibitor to the diluted H_2O_2 solution.
 - [c5] 5. The process of claim 4 wherein the Cu corrosion inhibitor comprises benzotriazole (BTA).
 - [c6] 6. The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises reducing the H_2O_2 concentration of the diluted H_2O_2 solution to below 100:1 (v/v).

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- [c7] 7.The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises lowering the temperature of the diluted H_2O_2 solution to below $15^\circ C$ during the application to the wafer of the diluted H_2O_2 solution.
- [c8] 8.The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises increasing the pH of the acidic cupric oxide cleaning solution to above 7.
- [c9] 9.A wet cleaning process comprising:
an oxidation step;
an oxide etch step for washing away cupric oxide generated in the oxidation step by means of a cupric oxide cleaning solution; and
reducing Cu deposition on a cathode-like copper wiring line of a Cu-dual damascene structure.
- [c10] 10.The process of claim 9 wherein the oxidation step is used to slightly oxidize a surface of a Cu wiring line in a dual damascene structure by utilizing a diluted H_2O_2 solution.
- [c11] 11.The process of claim 9 wherein the cupric oxide cleaning solution comprises diluted HF, NH_4F , NH_2OH , or diluted HF/HCl.
- [c12] 12.The process of claim 9 wherein the oxide generated in the oxidation step comprises CuO_x and $Cu(OH)_2$.
- [c13] 13.The process of claim 9 wherein the cathode-like copper wiring line is electrically connected with an N^+ diffusion region of a silicon substrate.
- [c14] 14.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises purging an inert gas during the oxidation process.
- [c15] 15.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises adding a Cu corrosion inhibitor to the diluted H_2O_2 solution.

- [c16] 16.The process of claim 15 wherein the Cu corrosion inhibitor comprises benzotriazole (BTA).
- [c17] 17.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises reducing the H_2O_2 concentration of the diluted H_2O_2 solution to below 100:1 (v/v).
- [c18] 18.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises lowering the temperature of the diluted H_2O_2 solution during the oxidation step to below 15 ° C.
- [c19] 19.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises increasing the pH of the cupric oxide cleaning solution to above 7.

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